

where there is much traffic requires re-covering about once in four years. Instances are given from the author's own experience where roads having a fair amount of traffic "have been as good at the end of six years as when first covered, and so far as can be seen will need very little for another six years."

This book ought to be carefully studied by all surveyors having charge of roads subject to motor traffic.

### VECTORIAL GRAPHICS.

*Vectors and Vector Diagrams applied to the Alternating Current Circuit.* By W. Cramp and C. F. Smith. Pp. xvi+252. (London: Longmans, Green and Co., 1909.) Price 7s. 6d. net.

NOT many years ago a certain type of journalist used to compare and contrast the theorist and the practical man, to the demolition of the former and the apotheosis of the latter. Fortunately, such an attitude of mind is no longer possible. The merely practical man could never have constructed the Forth Bridge, nor launched the *Mauritania* on her record-making career. Innumerable examples might be given of the necessity of true theory in the economical designing of all kinds of machinery; but probably there is nothing that better proves how much mathematical science lies at the foundation of modern methods than electrical applications, especially those that have to do with the alternating current. The whole history of the development of the transformer and the alternating-current motor is simply the realisation of the solution of a differential equation given long ago by Maxwell. In this realisation the first great steps were taken by Heaviside, who introduced the terms impedance, admittance, reluctance, &c., giving a new precision to the ideas involved. By a mathematical extension of meaning the symbols which entered into the electrical equations of steady currents became applicable to the corresponding cases of sinusoidal currents. Stated in purely mathematical language, this transition depended on the properties of the complex variable.

Thus, to take the simplest case, Ohm's law  $RC=E$  for steady electromotive force becomes Maxwell's expression  $(R+Ld/dt)C=E$  when  $E$  is variable. Representing a sinusoidal electromotive by the exponential of the imaginary  $ipt$ , we get the solution in the form  $(R+iLp)C=E$ , where  $C$  and  $E$  now stand for the amplitudes of the varying quantities. This complex quantity which operates on  $C$  may be treated analytically like the real quantity  $R$  in Ohm's law. Multiplication by the conjugate gives

$$(R^2+L^2p^2)C=(R-iLp)E.$$

In the end, after all analytical transformations have been effected, the real part of the expression must be picked out. A little experience will make the average student quite efficient in this kind of algebra, especially if it is combined with numerical and practical work.

But the value of the method does not stop here. Following familiar paths, we may give a geometrical form to the expressions, and obtain graphical repre-

sentations of important relations. Thus the complex quantity  $RC+iLpC$  may be laid down as a vector in a plane,  $RC$  being the component along a chosen direction and  $LpC$  the component at right angles to this direction, while the ratio  $Lp/R$  measures the tangent of the angle between the vector and the chosen direction of reference. Again, if we regard  $C$  as a complete vector, the complex operator may be considered to be a versor rotating  $C$  through the angle just named. Can we utilise these fundamental vectorial and versorial conceptions to construct a graphical representation of real value to the electrical engineer? The answer has been given in the affirmative; and among those who have worked up the method along these lines, no one holds a higher place than C. P. Steinmetz. The method has been presented in more or less detail in most of the recent books on the alternating current, and now we have an extremely valuable addition to the literature of the subject in "Vectors and Vector Diagrams applied to the Alternating Current Circuit," the joint work of William Cramp and Charles F. Smith, both lecturers in the electrical engineering school of Manchester University. The authors, for reasons given, depart somewhat from Steinmetz in their development of the method, but the foundation is essentially the same. Once the fundamental propositions are admitted and grasped, the whole treatment is a model of lucidity and self-consistency. One unusual feature of the book is that it assumes a certain fairly advanced knowledge at the start. This is a good feature, which might well characterise more of our text-books. The authors are careful at the same time to indicate exactly what knowledge the student must possess before he is in a position to make effective use of their methods—he must know the fundamental laws of the alternating-current circuit very thoroughly. Nevertheless, it would have been of advantage to have indicated in a few preliminary sections the manner in which the method originally took shape as a synthesis of the symbolic solutions of Maxwell's differential equations. There also seems to be a certain looseness of argument in the way in which the properties of vectors are stated. For example, having defined in the usual geometrical way the meaning of the "vector product" of two vectors, and having so named it, they remark, "This product must itself be a vector product, since it has already been shown to possess a definite sense." This is no proof, but mere statement. The defined product must be shown to obey the vector law of addition before it can be called a vector product.

These imperfections do not, however, affect the purpose of the authors, who are to be congratulated on having enriched our technical literature with a clear and systematic exposition of the vectorial graphics of alternating-current phenomena. After a discussion of the more purely geometrical character of the method, illustrated throughout by reference to familiar electrical phenomena, a succession of chapters follows on self and mutual induction, the transformer, motors of the induction type, and alternating-current commutator motors. A chapter is then thrown in on the product of two vectors, and the two concluding and longest chapters deal respectively with locus

diagrams and examples of the application of locus diagrams. The book is amply illustrated by more than a hundred diagrams. Everything is concise and to the point, and the student who *works* through its pages will find himself equipped with a valuable weapon of research.

### THE RECONSTRUCTIONAL ANATOMY OF THE KIDNEY.

*Untersuchungen über Bau und Entwicklung der Niere.* Edited by Prof. Karl Peter. Erstes Heft. Inhalt I., Karl Peter, Die Nierenkanälchen des Menschen und einiger Säugetiere. II., Michio Inouye, Die Nierenkanälchen des Rindes und des Tümmlers. Pp. viii+447. (Jena: Gustav Fischer, 1909.) Price 30 marks.

THE editor of this monograph holds with Koelliker that a knowledge of the morphological characteristics of the renal tubules is an important groundwork for the study of the physiology and diseases of the kidney. This ground plan he has laid down in a bulky volume, profusely illustrated by numerous and well-executed drawings. By means of maceration with concentrated hydrochloric acid and subsequent isolation of the urinary tubules, as well as by reconstruction models and serial microscopic sections, he has studied, along with his pupil, Michio Inouye, the structure of the kidney in various mammalian families in great detail. For the benefit of those who desire to ascertain his results without reading the whole of the text, he condenses a summary of his work into seventy-five pages of this volume.

Prof. Peter has worked out the structure of the kidney of the mouse, rabbit, sheep, cat, man, and pig, while Inouye has studied the organ in the seal and ox. They have given a minute description, perhaps too minute, of the organ in the various animals without adding, to any great extent, to our knowledge of the subject.

As a result of his study, Prof. Peter divides the medulla of the kidney into an inner and an outer zone, and the latter into an inner and an outer area. The cortex he divides into a *pars convoluta* and a *pars radiata*. These, to some extent, can be recognised with the unaided eye or by means of a lens, and each is composed of certain definite parts of the tubules, each zone or area being composed of the same parts in the same species. In fact, with some slight exceptions they are composed of the same parts throughout the whole of the mammalia. A summary of the zones and their contents is given.

These researches of Prof. Peter—minute and accurate as they are—have particularly little in them that will interest those who seek to elucidate the functions and diseases of the kidneys. The author himself states that as regards the significance of the Malpighian bodies his investigations have produced nothing new. Concerning the first convoluted and zigzag tubules which he includes under the name of the "Hauptstück," certain observations have been recorded with regard to variations in the amount of fat contained in the cells, and from the fact that these vary in their affinity for eosin in different parts of

the convoluted tubule, the deduction is made that the functions of the latter are not the same throughout its length. The facts adduced by these investigations have very little bearing on the two rival theories of the manner in which the kidney removes the urine from the blood—whether by a process of secretion or one of filtration.

The function of the narrow, clear part of the loop of Henle is concluded to be the resorption of the water which has been thrown out of the glomerulus. This is deduced from a ratio which Prof. Peter has found to exist between the relative length of this part of the tubule and the specific gravity of the urine in various mammalia with the exception of some of the smaller ruminants. In this matter his observations support the experiments of Ribbert and H. Marger, and of Hausmann. These experimenters removed the whole of one kidney and the medulla of the second in a rabbit, with the result that the urine was doubled or trebled in amount. As the narrow, clear part of the loop of Henle is contained in the medulla, it is inferred that the increase in the amount of urine is due to the removal of the resorbing part of the tubule. So many factors have to be considered in a case like this that the author's deductions must be regarded with a certain amount of reserve. While one must admire the industry and accuracy manifested by this work, it must also be admitted that even those specially interested will find it very tedious reading, and it is to be hoped that it may be possible to confine the other promised volumes within a more modest compass.

R. D. K.

### GREEKS AND HITTITES.

*Ionian and the East.* Six Lectures delivered before the University of London by D. G. Hogarth. Pp. 117. (Oxford: Clarendon Press, 1909.) Price 3s. 6d. net.

THE author of this book aims at solving the interesting problem of the origin of Hellenic civilisation in the Grecian colony of Ionia, in western Asia Minor. He utilises, in a masterly manner, the results of the extensive archaeological researches that have been carried out within the last thirty years in south-eastern Europe. The excavations of Schliemann, Evans, and numerous other workers in this field have completely revolutionised our ideas about the origin of that early Grecian culture to which modern European civilisation owes so much.

Mr. Hogarth's conclusions are, that in Attica the home country of the Ionians, the population, before the migration to Asia Minor, was mainly Ægean, but mixed with a northern element of invaders from the Danubian area. At this date there survived in Attica a vigorous bloom of Ægean culture affected to an unusual degree by some eastern influence, so that the colonists who settled on the west coast of Asia Minor in the early centuries of the first millennium B.C. were by no means barbarians. In Ionia the Greek settlers came in contact with a highly developed Asiatic civilisation—namely, that of the Hittites—and one of the most original features of Mr. Hogarth's book is the demonstration which he gives of the powerful influence of the Hittite civilisation in the develop-